DOCUMENT RESUME

ED 357 952 SE 053 104

AUTHOR Gallas, Karen
TITLE Metaphor and Analogy in Children's Science Talks.
PUB DATE 24 Apr 92
NOTE 19p.; Paper presented at the Annual Conference of the American Educational Research Association (San Francisco, CA, April, 1992).
PUB TYPE Reports - Descriptive (141) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Classroom Communication; Classroom Techniques; Cognitive Development; Cognitive Processes; Communication (Thought Transfer); Communication Skills; *Concept Formation; Constructivism (Learning); Creative Thinking; *Discussion (Teaching Technique); Discussion Groups; Elementary School Students; *Epistemology; *Metaphors; Primary Education; Science Education; *Science Instruction; Scientific Concepts; Scientific Literacy; Teaching Methods; Thinking Skills
IDENTIFIERS *Analogy; *Discourse; Science Talks

ABSTRACT

The science discourse of young children is a means by which children can pose and try to answer difficult questions about their world. This paper describes through excerpts from transcripts of audiotapes and fieldnotes of science talks, how young children talk about science, and how they use metaphors and analogies to develop theories about difficult scientific concepts. The paper is separated into four sections. The first section establishes a theoretical context for the practice of science talk in the classroom. The second section describes the teaching practice of conducting science talks and discusses the teacher's and student's roles during the discussions. The third section examines an illustrative text on the topic of how nature began. The fourth section concludes that science talk demonstrates that children are capable of devising insightful explanations for difficult questions concerning their world and suggests that teachers need to recover and reexperience this mode of thinking to make it part of the science teaching and learning process. (MDH)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED357952

METAPHOR AND ANALOGY IN CHILDREN'S SCIENCE TALKS

Karen Gallas
Lawrence School
Brookline, Massachusetts

Paper presented at the annual conference of the
American Educational Research Association
San Francisco, California
April, 1992

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

Karen K. Gallas

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

X This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

SE053104

T: How are colors made in nature?....Why are apples green from some trees, red from others? Why are carrots orange and why are roses red?

Jiana: It um, um, like um...Karen did with the um, eggs, like s-squirt that um, color stuff stuff in.

T: Mmhmm.

Jiana: it could be um, like, like rain, like makin' like different colors and rain can be goin' in those seeds because sometime when it rains, there, there are rainbows on the floor.

I am sitting on the floor, wedged between Donald on my right and Jiana on my left. Jiana has just proposed a theory about what makes different colors in nature to the twenty other first graders sitting in a circle with us. The children furrow their brows in an effort to follow her thought. Some are not even looking at her. Donald enters the discussion:

Donald: Well it might be how, like it might be how uh, like if it takes time, like if someone t-, puts um, wa-, waters a tree, like this time, and then, they water at the same time the next day, it might have, mi-, it might like get, um different colors because i-its different times like, like a red apple might be, like when someone um, waters a tree very early, or maybe, maybe it depends on um , ...like how, how many times the rain does...

"Jiana", I whisper. "Listen, they are talking about your idea." Jiana looks at me, then at Donald, then gets 'goofy' as I call it, rolling her eyes and pretending to fall over backwards. The other children continue to build on Jiana's idea.

Shelly: You know it could be, things that grow on trees may get like, water from the trees, and the sugar that comes, that's down... and the things that grow in the ground, probably, probably ha-, get the water, and the like...the soil from the ground, and, that's maybe how they get **a** color.

Robin: Pumpkins don't grow from trees.

Shelly: Well, um, I know.

Robin: They grow from the garden.

Shelly: but I was saying that, maybe, you know whatever it grows on, that was just, an example.

Sarah: Well you see, it could be from the rain. It could be, also from

> the rain because, the rain keeps recycling
> because... because um, do you know, really, the r-
> ... you know the rain that rains on us right now, it
> could be a hundred years old.....

This scene is part of our weekly science talks, an event I consider to be one of the most power packed parts of my weekly structure -- what another first grade teacher in my school has called "knee knocking talking". In these talks, children ask, and try to answer their own very difficult questions about the world. The talks, which originated as part of my research on how children talk about science, are now part of a larger study on how children make their thinking visible through narrative, writing and the arts.

What began as research on the science discourse of young children, very quickly moved beyond my original explorations into documenting their powerful abilities to question, theorize, and even inquire into what true knowledge is. In this paper, I hope to describe through excerpts from transcripts of audiotapes and fieldnotes of science talks, how young children talk about science, and how they use metaphor and analogy to develop theories about difficult concepts. This exploration of their thinking will also introduce a discussion that is just beginning for me, of the ways in which children, by talking outloud, explore their own understanding of epistemology -- in effect, how they study what true knowledge is, and who has access to it.

ESTABLISHING A THEORETICAL CONTEXT

> Just as with learning a foreign language, fluency
> in science requires practice at speaking, not just
> listening. It is when we have to put words
> together and make sense, when we have to
> formulate questions, argue, reason, and
> generalize, that we learn the thematics of science.
> (Lemke, 1990, p.24)

When describing the practice of science teaching talk in the classroom, Lemke both decries the limited scope of science talk in the classroom, and describes what it might be. His analysis includes a call for children to be able to use scientific language for themselves, and for teachers to recognize that a scientific theory "is a way of talking about a subject using a particular thematic pattern", rather than a "description of the way the

world really is." (p.126) Lemke's focused work on science talk reinforces the findings of other researchers about the potential of expanded formats for talk in the classroom. (Barnes; 1976, Britton; 1990, Bruner; 1986, Cazden; 1988, Hymes; 1980; Michaels; 1990)

Barnes (1976) describes the ways in which collaborative talk among peers enables secondary school students to work through difficult ideas more thoroughly than instances when the teacher is focusing the discussion. He cites the processes of exploratory talk and co-construction of meaning as important components of collaborative discussions, and notes that although the talk is messy, it is a time when children are engaged in higher level thinking. Britton (1990), proposes that informal language among peers aides them in working through new ideas, and suggests that expressive talk is more accessible to students, and hence must precede technical talk about science.

> It is the language of their own intimate musings, their inner reflections upon experience, that will serve both to bring their common-sense concepts to the point of engagement with the scientific concept, and to carry out the reconciliatory interpretation." (p.108)

Hymes and Cazden (1980) refer to the importance of narrative thinking as a "form of knowledge", and Hymes specifically relates what he terms "a weighted quality to incident in personal lives" that he views as a characteristic of native american perspective(p.134). This is a characteristic which I have also observed in the language of young children. It is my experience that children regularly take specific incidents, for example, Jiana's observation of "rainbows on the floor", or oil spills on city streets, and give them expanded meaning by incorporating them as a metaphor into their naratives.

Ricoeur (1983) in speaking of the congruence between the use of metaphor and the development of narrative, notes that although metaphor is a "figure of discourse", and narrative is a genre, "the meaning-effects produced by each of them belong to the same basic phenomenon of semantic innovation." (p. ix) Metaphor takes seemingly unrelated and possibly "incompatible" phenomena and produces a new semantic relationship through their juxtaposition. Narrative synthesizes diverse and separate actions, characters and events into a plot. "In both cases, the new thing -- the as yet unsaid, the unwritten -- spring up in language." Thus, in the process of building her theory, Jiana uses a metaphor that is embedded

in her brief narrative to reconcile unrelated images and events. The incident of egg dying was specifically used to illustrate, or point to an idea. At the time she obviously didn't say, 'Oh so that's how colors get in apples.', but in the framework of building a narrative which addressed a specific question, Jiana used her first experience with egg dying and coupled it with her observation of oil spills to make an attempt to develop a theory. Her thinking process clearly is one of semantic innovation and represents what Ricoeur calls "this power of the metaphorical utterance to redescribe a reality inaccessible to direct description." (p.xi.) He sees this use of poetic language as a means by which the individual can speak about issues of being in the world that are indescribable except through the process of crossing the boundaries of the normal and everyday use of language.

In their collaborative talk, I have repeatedly observed children using narratives to build theories. These narratives were initially very difficult for me to follow, and often led me to believe that the children weren't making any sense. However, I noticed in the midst of my confusion, that they didn't seem to have any trouble following each other's train of thought. For example, the following text came in a discussion focused on the question, "Why is it summer when the sun is further away from the world, and winter when the sun is closer?".

Vera:....like the North Pole where Santa lives....he, then Santa doesn't get any sun.
Sean: That is true.
T: Is that all year round Santa doesn't get any sun, or is there a time when Santa gets a lot of sun?
Vera: Well he gets some sun, but he never gets a lot.
Sean: Down below it only gets a little sun.
Gary: And that's how the middle is so hot.
T: Why?
Gary: Cause on the bottom, the the the world goes around the sun so when the sides are a little warm, the top isn't cold, so the middle has to be hot.
Vera: The middle, the middle's the closest to the sun cause the sides aren't as close, like this is the sun (*using her hands for a modell*) Now the sides go a little bit off... This is the sun, right? Now this is the earth. Now listen, its spinning around like this so

> only this part and this part and the like, the sun is going right for here, **and part of the sun is, its like its breaking up and its going like, like Peter Pan says, he says the first shadow broke into a thousand pieces.** Its like that, cause like **the sun's breaking up.** Its like parts of it, part of the sun's going to this part, a little bit of the sun's going to this part and most of the sun is going to this part.

This text is particularly striking because it shows three characteristics of science talking that six and seven year olds regularly demonstrate: using narrative, or storytelling talk to develop an idea, personifying to illustrate a point, and developing a metaphor or analogy to make the intellectual leap towards theory. For example, early in the text, Vera refers to Santa in the North Pole, and seriously uses that reference to develop a story about where the sun might not reach. Later, she says the sun is "breaking up", and in alluding to the literary reference of Peter Pan, she develops a very poetic metaphor to illustrate the idea of how sunlight might, in fact, break up as it hits the earth.

Leacock (1972) describes the power of metaphor as a tool for abstract thinking. She notes that "through the metaphor, the relevant characteristics of a situation are abstracted and stated in the form of an analogy that clearly divests it of extraneous features." (p.129) Because metaphor generally pulls an image from one context and places it in a new, and seemingly opposed reference, it abbreviates the connecting ideas from the first idea to the last, and as such requires the listener to make some leaps of thought. Rothenberg (1989), in describing how scientific thinking uses metaphoric thought to develop new theories, labels this process "Janusian thinking", using the reference to the Roman god Janus to illustrate how metaphoric thinking requires the thinker to reconcile two opposite ideas into a unified image. Vera's use of the image of shadows breaking up to talk about sunlight hitting the earth represents the practice of Janusian thinking in action. Her image of sunlight breaking up is related to a shadow breaking up, thus juxtaposing two opposite phenomena to illustrate a point. Though Vera's language is presented in a way that I often find difficult to follow, it is perfectly intelligible to her peers. Difficult ideas gain clarity through the development of the narrative, and metaphors are the bridge to the theory.

From the narratives which I have heard used in science talks, I have

concluded that children, even disadvantaged city children, observe their world very carefully, and **mark** certain observations with an invisible question mark, as it were. If the opportunity arises, many of these marked observations are then brought into play as potential symbolic representations of an idea. Often, however, adults mistake the child's symbolic representations as immature conceptualizations of an idea. In other words, Vera's reference to Santa Claus, or Peter Pan, in the midst of a science discussion would throw a distractor into the adult's thought pattern. When I hear the words 'Santa Claus', I immediately discount the statements to follow because the narrative has not followed the rules of theoretical science discourse. My stance as a listener changes from one of listening to one of evaluating. How can one take an idea about the sun's energy breaking up seriously when in the next breath, the child is using Peter Pan to complete the thought? Donaldson (1978) proposes that in some ways, it may be the adults, and not the children who need to decenter their thinking. My experience with science talks would appear to confirm that. Adults are often easily diverted because their thinking procedes hierarchically, rather than radiationally. What we consider to be quaint examples of the child's imaginative thought might more often be metaphoric attempts to build theories about how the world works.

SCIENCE TALKS

In its present form, the practice of science talk in our classroom richly represents what happens to children's talk when they are encouraged to speak collaboratively and develop ideas from their own life experience. This form developed, however, only after I had come to the painful conclusion that my role as the moderator of science discussions limited, rather than expanded the children's thinking. Although I had always assumed that my participation in science discussions helped the children to stay on topic, I quickly learned when I began to audiotape and transcribe the discussions that in fact while they did stay on topic, it was my topic they stayed on, rather than theirs. A comparison of an early science talk from the late fall of 1989 with a later talk from that same school year, will elucidate this point as well as demonstrate what happens when the teacher's voice is kept to a minimum. The first excerpt is from a talk when the question asked was, "**what will happen when we bury our Jack-o-lantern**?". It was asked by a child prior to an experiment in which we buried a jack-o-lantern in dirt. (References to "Karen" in the text refer to me. Each period refers to a one second pause.)

Ollie: Oh, Karen, Karen, I told you this before but I wanna tell the class. My friend,
T: Um hmm.
Ollie: she has a huge, giant pumpkin outside... on her table, her, um, porch table, and, you see, her pumpkin has been on that table since Halloween, and its not rotting.
Sean: N-N- neither is one of mine rotting, and I have two...
Ollie: And, and you see... and I think that it is because that those haven't been
Sean: In air?
Jeff: Outside?
Ollie: Yeah.
T: O.K. which we talked about earlier.
Ollie: But I've got one and you see
T: O.K.
Ollie: Remember the pumpkin that was on the step?
T: Yes.
Ollie: It was inside but it wasn't rotting.
Sean: But it fell down and broke.
Vera: Well, maybe its because you see, maybe its because this one rotted faster, because, um, maybe its because it was opened up, it was cut.
T: Umm. So, so what about this one that wasn't cut up and it just started to rot. Remember we talked about that
Sean: It fell down, and blew up.
T: It didn't really... What do you think Chloe?
Chloe: We had that one (referring to the pumpkin on the step) before we had this one.
T: This one here?
Chloe: Yeah.
T: Before we had that one there.
Chloe: We had that one before.
T: We had the jack-o-lantern before this newer one, but how did this newer one end up...Look, its ending up the same way.
Chloe: It still rots, but this one rotted first.
T: Yes, but they're both rotting.
In this text, it is clear that my purpose was to help make the

children's statements relate to the buried jack-o-lantern and the experiences inside the classroom. Yet the children kept making efforts to generalize to other experiences they had had with rotting pumpkins. Ollie wants to talk about her observation of her friend's pumpkin; Sean points out that only one of his is rotting. I felt that my task was to keep focusing the children, and in some cases to do that I took on the role of refuting a child's remark, for example, Sean's remark that "it fell down and blew up", mistaking his metaphor of falling down and blowing up to mean that Sean really thought the pumpkin had fallen. In fact, what his language was describing was the physical process of decomposition that one of our pumpkins had gone through. First it had collapsed, and then the whole mass had fermented and become, in effect a larger mass of liquid and mold.

Only when the children's remarks were made visible to me through transcribing them, did I look and see that in many cases I was missing the point of their comments, and also limiting where they might go with their talk. For example, both Ollie and Vera pointed out variables that might influence what would happen to a buried pumpkin: temperature and cutting. I chose not to pursue these in the interest of keeping the discussion in control. As a teacher researcher, when I began to review the transcripts of these talks, I saw that I had to change my level and style of participation in the talks so that the children's ideas could move to the forefront of the discussions. When I consciously withdrew my voice from the center of the discussions, the talk changed both in format and in depth, as the second excerpt which was focusing on the question "**Were dragons real?**", shows.

Juan: The dinosaurs were not, they were not dragons, but the birds they were must be dinosaurs. The dinosaur birds they were must be dragons.
T: You think they must be dragons, the dinosaurs? Juan is saying dinosaurs must be dragons.
Juan: The birds!
Vera: That's what I said. I said
T: The birds were?
Juan: That the birds were.
Jeff: No they weren't.
Gary: Cause dragons can fly, you know.
Vera: You know, the dinosaurs might have another name, like, they might, like God might call them, uh,

dragons, but we might think of them, we might call them dinosaurs.

Andy: Or terrible lizard.

Vera: Its just like when a baby's born and then the parents die and people don't know her real name was... they name her name, they give her a name.

Gary: Um ....um Andy gave me a brainstorm and Vera gives me a brainstorm. Well, Andy said dinosaur means terrible lizard

Jeff: which it does

Gary: .....Um.....Vera and um, Juan said that d-, some dinosaurs are really dragons. Well, since dinosaurs are terrible lizards, dragons were terrible lizards too, weren't they?

As this text shows, my level of verbal participation has dropped considerably, and even in the instance where I tried to moderate the talk for Juan, who was just learning to speak english, I misunderstood his meaning, and he corrected me. What was most surprising to me, however, as I changed my role in the talks, was the way in which children worked together, as Gary says, giving each other brainstorms: collaborating, exploring, making connections among seemingly unrelated experiences.

The process of science talks entails identifying important questions that children ask themselves about phenomena they observe in the world around them. Each September in my first grade classroom, we start a list of 'Science Talk Questions', and the list is added to as the year goes on. Questions which are added to the list must meet one requirement: no one in the class can know the answer. When a question is proposed, we generally check to make sure that it is new, and the answer is open to conjecture rather than easily found in a reference book. The following sample of a few of the questions from one class, give a sense of the depth of the questions young children ask.

What makes the wind?
Why is snow white?
How do seasons change?
What is too slow for the eye to see?
How are waves made?
What makes a mirror reflect?

In using the children's questions, I intended to tap into the child's

internal conversations, or personal narratives, which I remember from my childhood as accompanying my exploration of the world and which I often observed in my own children as they wandered alone outside. These conversations with oneself contain strands of thinking and reasoning which are rich in association, personification, metaphor, analogy, and often, misconceptions.

Normally in classrooms, these narratives are not placed in the public domain; they are rarely voiced within the context of the school day, and hence, their value as powerful tangents of thought are never tapped. Occasionally they find their way into the classroom record through informal discussions, creative writing, or more subtly, as images in a painting or drawing. The structure of science talks, then, was established so that the children would identify this type of thinking as part of the study of science. In essence, as Michaels (1990) points out, the science talks "ratify" or "privilege" the internal narratives, and prod the children to make their silent conversations public.

AN ILLUSTRATIVE TEXT: How did Nature Begin?

An examination of the text of one science talk will illustrate both the process of collaborative thinking, and the characteristics of the language that children use to express their ideas. This talk occured in the Spring of 1991. It opened with Robin, who made an attempt to identify the parameters of what they were considering. [Each dot indicates a one second pause.]

Robin:.....Nature was made, um, like with dirt and .. and seeds.. also um ... wi- ... and the uh.. sun.

Shelly:Well how were, how was the sun made? How was dirt made? How was o- how was oceans made?

Franny: So, Robin, that couldn't be 'cause, if we're talking about how nature was made it has to be like... how nature *was* made, you know?

Donald: Yeah, like

Franny: Cause

Robin:Yeah, but, but

Brandy: I think um, that um, nature was made like, from a like a seed like that was just like, under dirt, and then like, maybe um... like roots started like coming, and

then it, they dropped more seeds and them, um, all that plants came.

Robin:Maybe.

Donald: Maybe it was because, maybe..... Um. Maybe, you know, you know how, when like, um, how the leaves, kind of um.. um, you know how there was plants way long ago? For dinosaurs to eat? Well maybe the leaves fell off, sometimes and and they and they went, and they went deep into the ground, and you know the stems? The other part rotted and the stems, and they started to grow nature.

The other children immediately push to define the parameters of the talk further. They use very tentative language to propose more ideas, and they start with what they, themselves have observed in their world. The talks at this point are what Barnes (1976), labels exploratory. They sound messy, that is, the children use their language to collectively grope around for an idea than holds up to scrutiny, often returning to an early idea that's still nagging at them, and working to make it work or somehow refine it.

Brandy: I know Robin, but um, like h-how, like if... how is the dirt, like, made?

Jiana:Yeah, but maybe that when the seeds drop... the um the um.. the dirt started to grow when when they put the um, seeds in the um, under the ground.

Robin:but maybe

Franny: Robin, Robin, maybe the dirt was, I kind of agree with Robin, because maybe the dirt was made **before** the plants!

Donald: I know that has to be, because i-, plants can't grow without dirt.

Shelly: Right.

Brandy: Yeah, and seeds can't fall without trees.

T: So maybe we should go back even farther to the dirt.

Joel: That's true.

Robin:Yeah but, you know how someone

Joel: To the dirt or mud.

Robin: someone doesn't always talk about **something** first?

T: Yeah.
Robin: Maybe I wasn't talking about that first, maybe I was talking about the plants first.

In this case, the children return to Robin's initial proposal that it started with dirt, and they reason that dirt came before seeds, and seeds came before plants. Their attempts to work logically from one idea to the next, reducing the possible answers, is consistent in the early stages of the talks. Throughout the talks, the children think collaboratively, often building on one another's ideas in piggybacking fashion. To the adult listener, the trains of thought are often difficult to follow, and give the impression that the talk is going nowhere.

In the midst of the progression of ideas, children often comment on their own thinking process, hoping it will clarify why they made a statement. Robin pointed out to her friends that she had had the idea about the dirt early, but couldn't explain it right away: "you know how someone doesn't always talk about something first". In other words, it takes awhile to get to the point you start with. Her comment here, is typical of the kind of talking about thinking that occurs in the science talks along with the talk about the content of the science talks.

The talks, which last from twenty to thirty minutes, often procede in fits and starts. Generally in the middle of the talks, there is a lull, and the children appear to be befuddled. They seem to pause, regroup, and then one child will move forward. In this talk, Franny reintroduced the question of how far back in time they were looking.

Franny: When the dinosaurs were made, um, in a book it showed that there were plants so we have to go further back before the dinosaurs.
Sarah: If we wanna **do** plants. You could go like, um, when dinosaurs were, or you could go, you know, real far back.
Joel: Past dinosaurs i- there were, there were, sharks were alive, they were.
T: O.K. So back even further than that.
Franny: Well, then, I have an idea because if we went way, way, way back, then then, we couldn't say that there was no grass and
T: Was there ever a time, you think, when there was no grass?

Franny: I know, but then, if there was no grass, there might not be any water, so of course plants couldn't grow. There might not be any water if, because the plants need water to grow.

S So Franny has reduced the time frame once again back to a period when there was no water. Her logic caused the group to explode with excitement, and disorder broke out even among the teachers.

Shelly:Franny you're, right! So it coulda been that its too hot. That water started nature!
Student Teacher: Water that started nature?
Shelly: You know
Donald: There couldn't because
Shelly: because
T: Wait, wait, wait, wait, wait, wait, wait, wait, wait. I'm getting confused.
Franny: Like we can't grow without water, and
Sarah:We can't live without water.
Shelly: Plants can't live without water.
Andy:I can't live without it.
Donald: Monkeys, monkeys can't live without water....

Once the excitement subsided, the children tried to figure out how 'nature' might have started in the water. Joel proposed "**that plants live in the water, so way back, there were plants in the ocean.**" Franny had continued to wonder about how the plants got in the ocean, and she reintroduces the concept of the seed into the discussion: "**anyways if there were (plants), the oceans might not be able to get up to the plants so they can grow, and also, how would the seeds be in there because there were no seeds then.**" A few minutes later, Robin returns to Franny's problem of the seeds:

Robin:Maybe um, the um... um way way way way way way way way way way
T: millions of years?
Robin:Yeah before the dinosaurs were alive, there was no water.... Maybe the um, nature was made with uh, little, little seeds, very little, and people couldn't see them. Well I mean, well there were no people um,
Joel: But they're so small that people couldn't see them.

Robin:And then, um, it started to make a earth, and then, um....
well, I don't mean one seed, I mean lots of seeds
Franny: But there could, there couldn't be seeds made then.
Brandy: I know but Robin, that was what I said.

The children find this idea to be very dissonant, and they strongly refute her theory. Robin's metaphor, in which the symbol of the seed represents the beginning of life, is incompatible with their picture of the seed as something that grows in dirt. Brandy reminds her that she mentioned seeds earlier in the discussion. Robin persists, saying "but people have different ideas", and she makes a great effort to restate her idea. "**I mean that there were lots and lots of little little seeds, and then they started to get bigger and bigger and then it started to go together and make a big earth.**" She seems to be trying to explain an image she has of seeds combining to create the diversity on earth. The children still object, and Robin tries again:

Robin:I don't mean that there were, there were like, people, then.
Maybe there were like, little, whatever things in
them, and then they were, then they started to
come together and then they got, and then it got
bigger and bigger and bigger...
Shelly: What do you mean? What do you mean 'little things'?
Cause we don't really get any idea when you say
there were little things.
Robin:Well, but I don't know the word.
Shelly: Well, make one up!

Shortly thereafter, the discussion ended, but the talk about beginnings continued with this class for weeks afterward. Robin's use of the 'seed' as a symbol for something that might have started life in water was hotly debated, and the children began to look for books that discussed the earliest times on earth. Eventually we read *Life Story* by Virginia Burton (1962). The book confirmed in a very clear and simple way for the children that their thinking was close to the way scientists viewed the beginnings of life on earth, and they were certainly amazed at themselves.

CONCLUSION

As I've participated in these science talks, I have found that I am continuously amazed at the powerful and insightful thinking which six and

seven year olds consistently demonstrate. As they gain confidence in their abilities to "co-construct meanings"(Barnes, 1976), they grow more tenacious in their desire to follow muddy ideas through to the end. Their identities as thinkers expands to include the right to name the world in new ways -- as Shelly says when Robin doesn't know the word, "make it up!"-- and they begin to construct new theories, some of which are unnervingly close to the theories being proposed by scientists today.

What confounds me is how children of this age can often devise explanations for difficult questions which are very close to theories currently accepted by the scientific community, theories which they would not have had access to in the resources available to them. Through this process of thinking together and using their natural ability to make connections, young children show remarkable tenacity and creativity as thinkers; they are willing to grapple with the most difficult ideas, and they have no difficulty 'decentering' in the midst of a discussion. That is, their flexibility as thinkers enables them to work with many ideas at one time, and they constantly attempt to build stories and images which allow those ideas to be synthesized in a coherent theory.

Rothenberg's study of creativity in science illustrates how important theories result from a thinking process that uses the "leap of thought" to synthesize thinking. When scientists use metaphoric thinking, it is usually a personal and internal language that is not represented in the final description of the idea itself. No one is required to follow the path of that thinking to understand the idea. Yet this process is integral to the practice of science. It is one of the ways of talking science that Lemke, Britton and Barnes suggest children need to engage in to develop science concepts.

However when children use this kind of narrative to explain themselves, many adults find it difficult, if not impossible to follow them, and so discount the ideas embedded within the narrative. Because most teachers of science like myself (and I characterize teachers broadly here to include teachers from K through graduate education), have not experienced this kind of talk in the context of our own education, we rarely recognize it as a particular form of science discourse which should be encouraged and maintained throughout the child's experience as a student of science. As a result, we exclude it from the context of school science, and so at some point in the process of studying science, this natural gift for metaphoric thinking, this way of conceptualizing the world in narrative, is silenced and remains untapped as a powerful force in thinking and learning. I would suggest that teachers, and teachers of teachers need to recover and

reexperience this mode of thinking so that we can place it more centrally within the process of science teaching and learning.

REFERENCES

Barnes, D. (1976) *From communication to curriculum*. New York: Penguin.

_____,Britton, J. and Torbe, M. (1990) *Language, the learner and the school.* Portsmouth, NH: Heinemann.

Bruner, J. (1986) *Actual minds, possible worlds* . Cambridge, MA: Harvard University Press.

Cazden, C.B. (1988). *Classroom discourse: The Language of teaching and learning*. Portsmouth, NH.: Heinemann.

Hymes, D. (1980). *Language in education: Ethnolinguistic essays.* Washington, DC: Center for Applied Linguistics.

Leacock, E. (1972) Abstract vs concrete speech. In C. Cazden, V. John and D. Hymes, eds. *Functions of Language in the Classroom.* New York: Teachers College Press.

Lemke, J. L. (1990) *Talking science: Language, learning and values.*

Michaels, S. (1990) The dismantling of narrative. In A. McCabe & C Peterson (Eds), *Developing narrative structure* (pp. 303-351). Norwood, NJ: Erlbaum.

Ricoeur, P. (1984) *Time and narrative.* Chicago: Univ. of Chicago Press.

Rothenberg, A.(1979) *The emerging goddess.* Chicago: Univ. of Chicago Press.